JOURNAL OF THEORETICAL BIOLOGY

Co-Chief Editors: S. A. KAUFFMAN
L. WOLPERT

Editorial Board: N. BARTON
J. BONNER
A. CORNISH-BOWDEN
J. COWAN
J. A. DANI
F. DYSON
J. M. GELFAND
M. E. GILPIN
L. GLASS
A. GOLDBETER
B. GOODWIN
M. HASSALL
P. W. HEDRICK
T. B. L. KIRKWOOD
J. H. LEWIS
W. R. LIEB
R. B. LUFTIG
R. M. MAY
J. MAYNARD SMITH
J. D. MURRAY
T. OHTA
H. H. PATTEE
A. S. PERELSON
S. L. PIMM
J. RINZEL
M. R. ROSE
M. SAVAGEAU
P. SCHUSTER
T. TAKENAKA
J. TYSON
J. Z. YOUNG

QH
301
J75

VOLUME 152
September–October 1991

ACADEMIC PRESS

London San Diego New York Boston
Sydney Tokyo Toronto

Copyright © 1991, by Academic Press Limited

ALL RIGHTS RESERVED

No part of this volume may be reproduced in any form, by photostat, microfilm, or any other means, without written permission from the publishers.

Printed in Great Britain

Contents for Volume 152

Number 1, 7 September 1991

EDITOR'S PREFACE, Cornish-Bowden, A. i

OVÁDI, J., Physiological Significance of Metabolic Channelling . . 1

SRERE, P. A., Channeling: the Pathway that Cannot be Beaten . . . 23

MATHEWS, C. K., Metabolite Channelling in Deoxyribonucleotide and DNA Biosynthesis 25

WELCH, G. R. and MARMILLOT, P. R., Metabolic "Channeling" and Cellular Physiology 29

STITT, M., Channelling in Photosynthesis: the Sublime and the Ridiculous 35

CORNISH-BOWDEN, A., How Much Effect on Free Metabolite Concentrations does Channelling Have? 39

BATKE, J., Channelling by Loose Enzyme Complexes *in situ* is Likely, though Physiological Significance is Open for Speculation 41

EASTERBY, J. S., Homeostasis, Flexibility and Conflict in the Kinetic Advantage of Channelling 47

KELL, D. B., On the Physiological Significance of Metabolite Channelling: If, How, and Where, but not Why 49

KNOWLES, J. R., Calmer Waters in the Channel? 53

HEINRICH, R. and SCHUSTER, S., Is Metabolic Channelling the Complicated Solution to the Easy Problem of Reducing Transient Times? . . 57

CLEGG, J. S., The Physiological Significance of Metabolite Channeling: an Idea whose Time has Come 63

PETTERSSON, G., No Convincing Evidence is Available for Metabolite Channelling between Enzymes Forming Dynamic Complexes . . 65

GIERSCH, C., Pillow Strategy 71

SALERNO, C., Misleading Interpretations of Coupled Enzyme Kinetics . 73

MELÉNDEZ-HEVIA, E. and MONTERO, F., Channelling and Evolution of Metabolism 77

URETA, T., The Role of Isozymes in Metabolite Channelling . . . 81

SAVAGEAU, M. A., Metabolite Channeling: Implications for Regulation of Metabolism and for Quantitative Description of Reactions *in vivo* . 85

SRIVASTAVA, D. K., Physiological Constraints on Evolution of Enzymes for Cellular Metabolic Pathways 93

HOFMEYR, J.-H. S., Metabolite Channelling and Metabolic Regulation . 101

SPIVEY, H. O., Evidence of NADH Channeling between Dehydrogenases 103

FELL, D. A., Physiological Significance of Metabolite Channelling . . 109

CÁRDENAS, M. L., Are the Transitory Enzyme-Enzyme Complexes Found *in vitro* also Transitory *in vivo*? If so, are they Physiologically Important? 111

FRIEDRICH, P., Metabolic Compartmentation via "Quenching Enzymes" 115

GUTFREUND, H. and CHOCK, P. B., Substrate Channeling among Glycolytic Enzymes: Fact or Fiction 117

WESTERHOFF, H. V., Energetics and Control Aspects of Channelling . 123

HERVÉ, G., Semantics of Channeling and Microcompartmentation . . 131

SHULMAN, R. G., Is Channeling a Disproveable Hypothesis? . . . 133

OVÁDI, J., Physiological Significance of Metabolite Channelling: Author's Response to Commentaries 135

Number 2, 21 September 1991

IWASA, Y., SATŌ, K. and NAKASHIMA, S., Dynamic Modeling of Wave Regeneration (Shimagare) in Subalpine *Abies* Forests 143

VIDYBIDA, A. K., Selectivity and Sensitivity Improvement in Co-operative Systems with a Threshold in the Presence of Noise 159

KORONA, R., On the Role of Age and Body Size in Risky Animal Contests 165

MILLS, G. C., Cytochrome c: Gene Structure, Homology and Ancestral Relationships 177

ALERSTAM, T. and PETTERSSON, S.-G., Orientation Along Great Circles by Migrating Birds Using a Sun Compass 191

SCHNITZER, J. E. and LAMBRAKIS, K. C., Electrostatic Potential and Born Energy of Charged Molecules Interacting with Phospholipid Membranes: Calculation via 3-D Numerical Solution of the Full Poisson Equation 203

PEARSON, S. D., ACKERMAN, R. A. and SEAGRAVE, R. C., The Energetics of Embryonic Growth and Development. I. Oxygen Consumption, Biomass Growth, and Heat Production 223

SMITH, W. J., Singing is Based on Two Markedly Different Kinds of Signaling 241

NAKAMURA, K., Neural Time-resolution Depending on Waveform of Spikes 255

CHOWDHURY, D., SAHIMI, M. and STAUFFER, D., A Discrete Model for Immune Surveillance, Tumor Immunity and Cancer 263

MARIN, I., Sexual Isolation in *Drosophila* I. Theoretical Models for Multiple-choice Experiments 271

Errata 285

Number 3, 7 October 1991

VAZ NUNES, M., LEWIS, R. D. and SAUNDERS, D. S., A Coupled Oscillator Feedback System as a Model for the Photoperiodic Clock in Insects and Mites. I. The Basic Control System as a Model for Circadian Rhythms 287

VAZ NUNES, M., SAUNDERS, D. S. and LEWIS, R. D., A Coupled Oscillator Feedback System as a Model for the Photoperiodic Clock in Insects and Mites. II. Simulations of Photoperiodic Responses 299

RENAUD, F. and DE MEEÜS, T., A Simple Model of Host-Parasite Evolutionary Relationships. Parasitism: Compromise or Conflict? 319

BOUDREAU, P. R., DICKIE, L. M. and KERR, S. R., Body-size Spectra of Production and Biomass as System-level Indicators of Ecological Dynamics 329

MILLER, D. A., Useful Perspective on the Relation Between Biological and Physical Descriptions of Phenomena 341

FELSENSTEIN, J., Counting Phylogenetic Invariants in Some Simple Cases 357

STOKES, C. L. and LAUFFENBURGER, D. A., Analysis of the Roles of Microvessel Endothelial Cell Random Motility and Chemotaxis in Angiogenesis 377

BARRAI, I., SCAPOLI, C., GAMBARI, R. and BRUNGNOLI, F., Frequencies of Codons in Histones, Tubulins and Fibrinogen: Bias due to Interference Between Transcription Signals and Protein Function 405

LETTER TO THE EDITOR

ELDER, D., Evolution of Split Genes 427

Number 4, 21 October 1991

MJOLSNESS, E., SHARP, D. H. and REINITZ, J., A Connectionist Model of Development 429

Beloussov, L. V. and Lakirev, A. V., Generative Rules for the Morphogenesis of Epithelial Tubes 455

Robertson, D. S., Feedback Theory and Darwinian Evolution . . 469

Gotts, N. M. and Vollrath, F., Artificial Intelligence Modelling of Web-building in the Garden Cross Spider 485

Berger, D. S., Modification of a Simple Fractal Tree Growth Scheme: Implications on Growth, Variation, and Evolution 513

Bulsara, A., Jacobs, E. W., Zhou, T., Moss, F. and Kiss, L., Stochastic Resonance in a Single Neuron Model: Theory and Analog Simulation 531

Ratnieks, F. L. W., Evolution of Discriminatory Aggression in Marine Invertebrates 557

Letter to the Editor

James, W. H., The Combinations of the Sexes of Mammalian Sibs and Littermates: and the Possibility of Adaptive Control . . . 567

Errata 569

Index to Volume 152

Abies forests, subalpine, dynamic modeling of wave regeneration (shimagare) in, 143
ACKERMAN,R. A. (see PEARSON, S. D.), 223
Adaptive control, the possibility of; the combinations of the sexes of mammalian sibs and littermates (letter), 567
Age: role in risky animal contests, 165
Aggression, discriminatory, in marine invertebrates, evolution of, 557
ALERSTAM, T. and PETTERSSON, S.-G., Orientation along great circles by migrating birds using a sun compass, 191
Ancestral relationships, cytochrome c, 177
Angiogenesis, analysis of the roles of microvessel endothelial cell random motility and chemotaxis in, 377
Animal contests, risky, role of age and body size in, 165
Artificial intelligence modelling of web-building in the garden cross spider, 485

BARRAI, I., SCAPOLI, C., GAMBARI, R., and BRUNGNOLI, F., Frequencies of codons in histones, tubulins and fibrinogen: bias due to interference between transcriptions signals and protein function, 405
BATKE, J., Channelling by loose enzyme complexes *in situ* is likely, though physiological significance is open for speculation, 41
BELOUSSOV, L. V. and LAKIREV, A. V., Generative rules for the morphogenesis of epithelial tubes, 455
BERGER, D. S., Modification of a simple fractal tree growth scheme: implications on growth, variation and evolution, 513
Biological and physical descriptions of phenomena, useful perspective on the relation between, 341
Biomass, body-size spectra of production and, as system-level indicators of ecological dynamics, 329
Biomass growth; energetics of embryonic growth and development, 223
Birds, migrating; orientation along great circles using a sun compass, 191
Body size: role in risky animal contests, 165
Body-size spectra of production and biomass as system-level indicators of ecological dynamics, 329
BOUDREAU, P. R., DICKIE, L. M. and KERR, S. R., Body-size spectra of production and biomass as system-level indicators of ecological dynamics, 329
BRUNGNOLI, F. (see BARRAI, I.), 405
BULSARA, A., JACOBS, E. W., ZHOU, T., MOSS, F. and KISS, L., Stochastic resonance in a single neuron model: theory and analog simulation, 531

Cancer: a discrete model, 263
CÁRDENAS, M. L., Are the transitory enzyme-enzyme complexes found *in vitro* also transitory *in vivo*? If so are they physiologically important?, 111
Cellular metabolic pathways, physiological constraints on evolution of enzymes for, 93
Cellular physiology and metabolic channelling, 29
Channel, calmer water in?, 53
Channelling: is it a disproveable hypothesis?, 133

Channelling: energetics and control aspects, 123
Channelling by loose enzyme complexes *in situ* is likely, though physiological significance is open for speculation, 41
Channelling and evolution of metabolism, 77
Channelling: homeostasis, flexibilty and conflict in the kinetic advantage, 47
Channelling: how much effect does it have on free metabolite concentrations?, 39
Channelling, metabolic, and cellular physiology, 29
Channelling, metabolic, physiological significance of, 1
Channelling, metabolite: is it the complicated solution to the easy problem of reducing transient times!, 57
Channelling, metabolite, in deoxyribonucleotide and DNA biosynthesis, 25
Channelling, metabolite, the role of isozymes in, 81
Channelling, metabolite, between enzymes forming dynamic complexes, no convincing evidence is available for, 65
Channelling, metabolite, and metabolite regulation, 101
Channelling, metabolite; physiological significance, 109
Channelling, metabolite, physiological significance of; an idea whose time has come, 63
Channelling, metabolite, the physiological significance of; if, how, and where, but not why, 49
Channelling, metabolite, physiological significance of (author's response to commentaries), 135
Channelling, metabolite; implications for regulation of metabolism and for quantitative description of reactions *in vivo*, 85
Channelling and microcompartmentation, semantics of, 131
Channelling, NADH, between dehydrogenases, 103
Channelling: the pathway that cannot be beaten, 23
Channelling in photosynthesis: the sublime and the ridiculous, 35
Channelling: pillow strategy, 71
Channelling, substrate, among glycolytic enzymes: fact or fiction, 117
Charged molecules interacting with phospholipid membranes, electrostatic potential and Born energy of; calculation via 3-D numerical solution of full Poisson equation, 203
Chemotaxis, analysis of the roles of microvessel endothelial cell random motility and, in angiogenesis, 377
CHOCK, P. B. (See GUTFREUND, H.), 117
CHOWDHURY, D., SAHIMI, M. and STAUFFER, D., A discrete model for immune surveillance, tumor immunity and cancer, 263
Circadian rhythms in insects and mites: a coupled oscillator feedback system as a model for the photoperiodic clock, 287
CLEGG, J. S., The physiological significance of metabolite channelling: an idea whose time has come, 63
Codon frequencies in histones, tubulins and fibrinogen: bias due to intereference between transcription signals and protein function, 405
Compartmentation, metabolic, via "quenching enzymes", 115
Compromise and parasitism, 319
Conflict and parasitism, 319
Connectionist model of development, 429
Contests, animal, risky, role of age and body size in, 165
Control aspects of channelling, 123
Co-operative systems with a threshold in the presence of noise, selectivity and sensitivity improvement in, 159
CORNISH-BOWDEN, A., Editor's Preface, i
CORNISH-BOWDEN, A., How much effect on free metabolite concentrations does channelling have?, 39
Counting phylogenetic invariants in some simple cases, 357

Coupled oscillator feedback system as a model for the photoperiodic clock in insects and mites. The basic control system as a model for circadian rhythms, 287
Coupled oscillator feedback system as a model for the photoperiodic clock in insects and mites; simulations of photoperiodic responses, 299
Cytochrome c: gene structure, homology and ancestral relationships, 177

Dehydrogenases, NADH channelling between, 103
DE MEEÜS, T. (see RENAUD, F.), 319
Deoxyribonucleotide and DNA biosynthesis, metabolite channelling in, 25
Development: a connectionist model, 429
DICKIE, L. M. (see BOUDREAU, P. R.), 329
DNA biosynthesis, metabolite channelling in deoxyribonucleotide and, 25
Drosophila, sexual isolation in; theoretical models for multiple-choice experiments, 271
Dynamic modeling of wave regeneration (shimagare) in subalpine *Abies* forests, 143
Dynamics, ecological, body-size spectra of production and biomass as system-level indicators of, 329

EASTERBY, J. S., Homeostasis, flexibility and conflict in the kinetic advantage of channelling, 47
Ecological dynamics, body-size spectra of production and biomass as system-level indicators of, 329
ELDER, D., Evolution of split genes (letter), 427
Electrostatic potential and Born energy of charged molecules interacting with phospholipid membranes. Calculation via 3-D numerical solution of the full Poisson equation, 203
Embryonic growth and development; oxygen consumption, biomass growth, and heat production, 223
Endothelial cell random motility and chemotaxis, microvessel; analysis of roles in angiogenesis, 377
Energetics of channelling, 123
Energetics of embryonic growth and development; oxygen consumption, biomass growth, and heat production, 223
Enzyme complexes, loose; channelling *in situ* is likely, though physiological significance is open for speculation, 41
Enzyme-enzyme transitory complexes found *in vitro*; are they also found *in vivo*?; if so, are they physiologically important?, 111
Enzymes forming dynamic complexes, no convincing evidence is available for metabolite channelling between, 65
Enzymes, glycolytic, substrate channelling among; fact or fiction, 117
Enzyme kinetics, couled, misleading interpretations of, 73
Enzymes, physiological constraints on evolution of, for cellular metabolic pathways, 93
Enzymes, quenching, and metabolic compartmentation, 115
Epithelial tubes, generative rules for the morphogenesis of, 455
Evolution, Darwinian, and feedback theory, 469
Evolution of discriminatory aggression in marine invertebrates, 557
Evolution of enzymes, physiological constraints on, for cellular metabolic pathways, 93
Evolution of metabolism, and channelling, 77
Evolution; modification of a simple fractal tree growth scheme, 513
Evolution of split genes (letter), 427
Evolutionary relationships, host–parasite, a simple model; parasitism: compromise or conflict?, 319

Feedback theory and Darwinian evolution, 469
FELL, D. A., Physiological significance of metabolite channelling, 109
FELSENSTEIN, J., Counting phylogenetic invariants in some simple cases, 357

Fibrinogen, histones and tubulins, frequencies of codons in; bias due to interference between transcription signals and protein function, 405
Forests, *Abies*, subalpine, dynamic modeling of wave regeneration (shimagare) in, 143
Fractal tree growth scheme, modification of; implications on growth, variation and evolution, 513
FRIEDRICH, P., Metabolic compartmentation via "quenching enzymes", 115

GAMBARI, R. (see BARRAI, I.), 405
Genes, split, evolution of (letter), 427
Gene structure of cytochrome c, 177
GIERSCH, C., Pillow strategy, 71
GOTTS, N. M. and VOLLRATH, F., Artificial intelligence modelling of web-building in the garden cross spider, 485
Great circles, orientation along, by migrating birds using a sun compass, 191
Growth and development, embryonic, energetics of; oxygen consumption, biomass growth and heat production, 223
Growth; modification of a simple fractal tree growth scheme, 513
GUTFREUND, H. and CHOCK, P. B., Substrate channelling among glycolytic enzymes: fact or fiction, 117

Heat production; energetics of embryonic growth and development, 223
HEINRICH, R. and SCHUSTER, S., Is netabolic channelling the complicated solution to the easy problem of reducing transient times?, 57
HERVÉ, G., Semantics of channelling and microcompartmentation, 131
Histones, tubulins and fibrinogen, frequencies of codons in; bias due to interference between transcription signals and protein function, 405
HOFMEYR, J.-H. S., Metabolite channelling and metabolic regulation, 101
Homeostasis, flexibility and conflict in the kinetic advantage of channelling, 47
Homology, cytochrome c, 177
Host-parasite evolutionary relationships, a simple model; parasitism: compromise or conflict?, 319

Immune suveillance, tumor immunity and cancer, a discrete model for, 263
Insects and mites, a coupled oscillator feedback system as a model for the periodic clock in; the basic control system as a model for circadian rhythms, 287
Insects and mites, a coupled oscillator feedback system as a model for the periodic clock in; simulations of photoperiodic responses, 299
Invertebrates, marine, evolution of discriminatory aggression in, 557
Isozymes; role in metabolite channelling, 81
IWASA, Y., SATÖ, K. and NAKASHIMA, S., Dynamic modeling of wave regeneration (shimagare) in subalpine *Abies* forests, 143

JACOBS, E. W. (see BULSARA, A.), 531
JAMES, W. H., The combinations of the sexes of mammalian sibs and littermates: and the possiblity of adaptive control (letter), 567

KELL, D. B., On the physiological significance of metabolite channeling: if, how, and where, but not why, 49
KERR, S. R. (see BOUDREAU, P. R.), 329
Kinetic advantage of channelling; homeostasis, flexibility and conflict, 47
Kinetics, coupled enzyme, misleading interpretations of, 73
KISS, L. (see BULSARA, A.), 531
KNOWLES, J. R., Calmer waters in the channel?, 53
KORONA, R., On the role of age and body size in risky animal contests, 165

LAKIREV, A. V. (see BELOUSSOV, L. V.), 455
LAMBRAKIS, K. C. (see SCHNITZER, J. E.), 203
LAUFFENBURGER, D. A. (see STOKES, C. L.), 377
LEWIS, R. D. (see VAZ NUNES, M.), 287, 299
Littermates and sibs, mammalian, the combinations of the sexes of, and the possibility of adaptive control (letter), 567

Mammalian sibs and littermates, combinations of the sexes of, and the possibilty of adaptive control (letter), 567
MARIN, I., Sexual isolation in *Drosophila* I. Theoretical models for multiple-choice experiments, 271
Marine invertebrates, evolution of discriminatory aggression in, 557
MARMILLOT, P. R. (see WELCH, G. R.), 29
MATHEWS, C. K., Metabolite channelling in deoxyribonucleotide and DNA biosynthesis, 25
MELÉNDEZ-HEVIA, E. and MONTERO, F., Channelling and evolution of metabolism, 77
Membranes, phospholipid, electrostatic potential and Born energy of charged molecules interacting with; calculation via 3-D numerical solution of full Poisson equation, 203
Metabolic compartmentation via "quenching enzymes", 115
Metabolite channelling *see* Channelling
Metabolite concentrations: how much effect does channelling have?, 39
Microcompartmentation, semantics of channelling and, 131
Microvessel endothelial cell random motility and chemotaxis; analysis of roles in angiogenesis, 377
Migrating birds; orientation along great circles using a sun compass, 191
MILLER, D. A., Useful perspectives on the relation between biological and physical descriptions of phenomena, 341
MILLS, G. C., Cytochrome c: gene structure, homology and ancestral relationships, 177
Mites, a coupled oscillator feedback system as a model for the photoperiodic clock in insects and; the basic control system as a model for circadian rhythms, 287
Mites, a couled oscillator feedback system as a model for the photoperiodic clock in insects and; simulations of photoperidic responses, 299
MJOLSNESS, E., SHARP, D. H. and REINITZ, J., A connectionist model of development, 429
MONTERO, F. (see MELÉNDEZ-HEVIA, E.), 77
Morphogenesis of epithelial tubes, generative rules for, 455
MOSS, F. (see BULSARA, A.), 131
Motility, random, endothelial cell, microvessel: role in angiogenesis, 377

NADH channelling between dehydrogenases, 103
NAKAMURA, K., Neural time-resolution depending on waveform of spikes, 255
NAKASHIMA, S. (see IWASA, Y.), 143
Neural time-resolution depending on waveform of spikes, 255
Neuron, single, model, stochastic resonance in; theory and simulation, 531
Noise, selectivity and sensitivity improvement in co-operative systems with a threshold in the presence of, 159

Orientation along great circles by migrating birds using a sun compass, 191
OVÁDI, J., Physiological significance of metabolic channelling, 1
OVÁDI, J., Physiological significance of metabolite channelling: Author's response to commentaries, 135
Oxygen consumption: energetics of embryonic growth and development, 223

Parasitism: compromise or conflict?; a simple model of host–parasite evolutionary relationships, 319
Pathway that cannot be beaten: channeling, 23

Pathways, metabolic, cellular, physiological constraints on evolution of enzymes for, 93
PEARSON, S. D., ACKERMAN, R. A. and SEAGRAVE, R. C., The energetics of embryonic growth and development. I. Oxygen consumption, biomass growth, and heat production, 223
PETTERSSON, G., No convincing evidence is available for metabolite channeling between enzymes forming dynamic complexes, 65
PETTERSSON, S.-G. (see ALERSTAM, T.), 191
Phospholipid membranes, electrostatic potential and Born energy of charged molecules interacting with; calcultion vis 3-D numerical solution of full Poisson equation, 203
Photoperiodic clock in insects and mites, a coupled oscillator feedback system as a model; the basic control system as a model in circadian rhythms, 287
Photoperiodic clock in insects and mites, a coupled oscillator feedback system as a model; simulations of photoperiodic response, 299
Photosynthesis, channelling in; the sublime and the ridiculous, 35
Phylogenetic invariants, counting, in some simple cases, 357
Physical and biological descriptions of phenomena, useful perspective on the relation between, 341
Physiological constraints on evolution of enzymes for cellular metabolic pathways, 93
Physiological importance of transitory enzyme-enzyme complexes, 111
Physiological significance of metabolic channelling, 1, 109
Physiological significance of metabolite channelling: an idea whose time has come, 63
Physiological significance of metabolite channelling: if, how, and where, but not why, 49
Physiological significance of metabolite channelling (author's response to commentaries), 135
Physiological significance is open for speculation; channelling by loose enzyme complexes *in situ* is likely, 41
Production and biomass, body-size spectra of, as system-level indicators of ecological dynamics, 329
Protein function, bias due to interference between transcription signals and; frequencies of codons in histone, tubulins and fibrinogen, 405

RATNIEKS, F. L. W., Evolution of discrminatory aggression in marine invertebrates, 557
Regulation, metabolic, and metabolite channelling, 101
Regulation of metabolism, implications of metabolite channelling for, 85
REINITZ, J. (see MJOLSNESS, E.), 429
RENAUD, F. and DE MEEÜS, T., A simple model of host-parasite evolutionary relationships. Parasitism: compromise or conflict?, 319
Risky animal contests, role of age and body size in, 165
ROBERTSON, D. S., Feedback theory and Darwinian evolution, 469

SAHIMI, M. (see CHOWDHURY, D.), 263
SALERNO, C., Misleading interpretations of coupled enzyme kinetics, 73
SÄTO, K. (see IWASA, Y.), 143
SAUNDERS, D. S. (see VAZ NUNES, M.), 287, 299
SAVAGEAU, M. A., Metabolite channelling: implications for regulation of metabolism and for quantitative description fo reactions *in vivo*, 85
SCAPOLI, C. (see BARRAI, I.), 405
SCHNITZER, J. E. and LAMBRAKIS, K. C., Electrostatic potential and Born energy of charged molecules interacting with phospholipid membranes: calculation via 3-D numerical solution of the full Poisson equation, 203
SCHUSTER, S. (see HEINRICH, R.), 57
SEAGRAVE, R. C. (see PEARSON, S. D.), 233
Selectivity and sensitivity improvement in co-operative systems with a threshold in the presence of noise, 159
Semantics of channelling microcompartmentation, 131
Sexes of mammalian sibs and littermates, the combinations of, and the possiblity of adaptive control (letter), 567

Sexual isolation in *Drosophila*. Theoretical models for multiple-choice experiments, 271
SHARP, D. H. (see MJOLSNESS, E.), 429
Shimagare: dynamic modeling of wave regeneration in subalpine *Abies* forests, 143
SHULMAN, R. G., Is channelling a disprovable hypothesis?, 133
Sibs and littermates, mammalian, the combinations of the sexes of, and the possibility of adaptive control (letter), 567
Signaling, singing is based on two markedly different kinds of, 241
Singing is based on two markedly different kinds of signaling, 241
Size-body spectra of production and biomass as system-level indicators of ecological dynamics, 329
Size of body: role in risky animal contests, 165
SMITH, W. J., Singing is based on two markedly different kinds of signaling, 241
Spider, garden cross, artificial intelligence modelling of web-building in, 485
SPIVEY, H. O., Evidence of NADH channelling between dehydrogenases, 103
SRERE, P. A., Channelling: the pathway that cannot be beaten, 23
SRIVASTAVA, D. K., Physiological constraints on evolution of enzymes for cellular metabolic pathways, 93
STAUFFER, D. (see CHOWDHURY, D.), 263
STITT, M., Channelling in photosynthesis: the sublime and the ridiculous, 35
Stochastic resonance in a single neuron model; theory and analog simulation, 531
STOKES, C. L. and LAUFFENBURGER, D. A., Analysis of the roles of microvessel endothelial cell random motility and chemotaxis in angiogenesis, 377
Sun compass, orientation along great cricles by migrating birds using, 191

Threshold in the presence of noise, selectivity and sensitivity improvement in co-operative systems with, 159
Time-resolution, neural, depending on waveform of spikes, 255
Transcription signals and protein function, bias due to interference between; frequencies of codons in histones, tubulins and fibrinogen, 405
Transient times and metabolic channelling, 57
Tubes, epithelial, generative rules for the morphogenesis of, 455
Tubulins, histones and fibrinogen, frequencies of codons in; bias due to interference between transcription signals and protein function, 405
Tumor immunity: a discrete model, 263

URETA, T., The role of isozymes in metabolite channelling, 81

Variation; modification of a simple fractal tree growth scheme, 513
VAZ NUNES, M., LEWIS, R. D. and SAUNDERS, D. S., A coupled oscillator feedback system as a model for the photoperiodic clock in insects and mites. I. The basic control system as a model for circadian rhythms, 287
VAZ NUNES, M., SAUNDERS, D. S. and LEWIS, R. D., A coupled oscillator feedback system as a model for the photoperiodic clock in insects and mites. II. Simulations of photoperiodic responses, 299
VIDYBIDA, A. K., Selectivity and sensitivity and sensitivity improvement in co-operative systems with a threshold in the presence of noise, 159
VOLLRATH, F. (see GOTTS, N. M.), 485

Wave regeneration (shimagare) in subalpine *Abies* forests, dynamic modeling of, 143
Waveform of spikes, neural time-resolution depending on, 255
Web-building in the garden cross spider, artificial intelligence modelling of, 485
WELCH, G. R. and MARMILLOT, P. R., Metabolic "Channeling" and cellular physiology, 29
WESTERHOFF, H. V., Energetics and control aspects of channelling, 123

ZHOU, T. (see BULSARA, A.), 531